Searching for Lidcombe Program mechanisms of action: Inter-turn speaker latency

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ABSTRACT

The Lidcombe Program is a well-established and efficacious treatment for early stuttering, but little is currently known about its mechanisms of action. The present report explores the possibility that inter-turn speaker latency might be associated with such mechanisms of action. Inter-turn speaker latency was measured in audio recordings of children, parents, and clinicians conversing, taken during Lidcombe Program treatment consultations. Five clinicians reduced their inter-turn speaker latencies during clinical consultations when they were speaking to children, in comparison with when they were speaking to parents. It is possible that inter-turn speaker latency is associated with the Lidcombe Program treatment process vicariously, and this possibility requires further research.

Keywords: Early stuttering, Lidcombe Program, mechanisms of action, speaker latency

INTRODUCTION

The Lidcombe Program

The Lidcombe Program is a well-established and efficacious treatment for early stuttering with empirical support from several randomized control trials involving different treatment formats: in-clinic (Jones et al., 2005; Lattermann et al., 2008), telepractice (Bridgman et al., 2016), and group (Arnott et al., 2014). Several reviews confirm the Lidcombe Program as the most empirically supported early stuttering intervention (Baxter et al., 2015, Blomgren, 2013; Brignell et al., 2021; Nye and Hahs-Vaughn, 2011; Nye et al., 2013; Sjøstrand et al. (2021). In a Cochrane Review, Sjøstrand et al. (2021) noted that it is the only early intervention treatment with an effect size that has been established with reference to several no-treatment control groups. However, Sjøstrand et al. suggested cautious interpretation of the results "due to the very low and moderate certainty of the evidence and the high risk of bias" (p. 2). A standalone internet version of the treatment (Van Eerdenbrugh et al., 2018) is currently being developed.

The Lidcombe Program consists of two Stages. During Stage 1, the parent and child consult weekly with a speech-language pathologist (SLP) for 45 to 60 minutes. The goal of treatment is no stuttering, or nearly no stuttering, that is maintained according to the specified criteria for progression to Stage 2 (maintenance). Treatment progress and outcome are measured using a 10-point stuttering severity rating scale where 0 = *no stuttering*, 1 = *extremely mild stuttering* and 9 = *extremely severe stuttering.* Parents record stuttering severity ratings each day. Children progress to Stage 2 when severity ratings are mostly 0.

Parent verbal contingencies

The Lidcombe Program treatment process involves parent verbal contingences for stuttered and stutter-free speech. Its development was based on experimental findings that response contingent stimulation could reduce stuttering in young children (Manning et al., 1976; Martin et al., 1972; Reed and Godden, 1977). Initial Lidcombe Program research associated parent verbal contingencies with a reduction of stuttering (Onslow et al., 1997, 2001). Parents are trained by a SLP to provide verbal contingencies for their children's speech. Five parent verbal contingencies are provided for either stutter-free speech or for unambiguous stuttering. These are 'acknowledge', 'praise', or 'request self-evaluation' for stutter-free speech, and 'acknowledge' or 'request self-correction' for unambiguous stuttering (Onslow et al., 2021). These parent verbal contingencies are provided to the child during practice sessions and during natural conversations.

The prominence of verbal contingencies in the Lidcombe Program treatment process is based on the assumption that they are the mechanism of action underpinning the treatment. At present there are no indications of any other mechanism that might explain treatment effects. Acoustic changes in child speech—vowel duration, intervocalic interval, voice onset time, articulation rate—do not seem to be involved (Bonelli et al., 2000; Onslow et al., 2002). Additionally, the following post-treatment changes in child or parent speech behaviour do not seem to be involved: mean length of utterances, type-token ratio, development sentence score, number of different words, requests for clarification, and requests for information (Bonelli et al., 2000; Imeson et al., 2018).

Researchers have hypothesized that verbal contingencies may not be the mechanism of action underpinning the Lidcombe Program (Bernstein Ratner, 2005; Hayhow, 2011), and experimental research has not successfully identified verbal contingencies as the mechanism of action underpinning the treatment; three reports have failed to identify verbal contingencies as a mechanism of action (Carr Swift et al., 2011, 2016; Donaghy et al., 2015), and two reports have provided partial support for their potential contribution to treatment effects (Donaghy et al., 2020; Harrison et al., 2004). A recent randomized controlled trial compared the Lidcombe Program with a modified version of the Lidcombe Program that did not contain verbal contingencies (Donaghy et al., 2020). Results indicated that noninferiority of the two treatment arms was inconclusive, based on a margin of 1.0% syllables stuttered. The authors stated that 'the inconclusive finding of noninferiority means it is possible verbal contingencies are active therapeutic agents, but not entirely responsible for Lidcombe Program treatment effect.' (p. 24). They also called for a shift to investigate variables other than verbal contingences.

Inter-turn speaker latency

Knowledge about 'mechanisms of action' (Zanca et al., 2019) for the Lidcombe Program is necessary to enhance its treatment efficacy and efficiency. Such knowledge can improve treatment efficiency by removing treatment components that do not contribute to treatment outcome. With this in mind, it is of interest that a randomized trial showed a similar pattern of temporal clinical responsiveness for the Lidcombe Program and RESTART-DCM treatment (de Sonneville-Koedoot et al., 2015; Figure 2). This is of interest because RESTART-DCM, which is based on the Demands and Capacities Model (Adams, 1990; Starkweather and Gottwald, 1990), appears to be a completely different treatment to the Lidcombe Program. The Lidcombe Program incorporates the operant method of parent verbal contingencies, and RESTART-DCM instates broad changes to the family living environment, which include parent verbal and linguistic behaviour.

One possible explanation for the similar outcomes of Lidcombe Program and RESTART-DCM treatment, as suggested by de Sonneville-Koedoot et al. (2015), is that there are mechanisms that are common to both treatments. Modelling of increased inter-turn speaker latency by adults is one procedure which aims to reduce stuttering during RESTART-DCM treatment; all parents are required to do so during the treatment process: 'The parent . . . inserts generous pauses during interactions between conversation turns (between 1–2 seconds), definitely no overlapping speech' (Franken and Putker-de Bruijn, 2007, p. 8).

Inter-turn speaker latency is the silent period between the moment when one speaker terminates an utterance and another speaker commences an utterance or ‘takes a turn’ (Newman and Smit, 1989; Sacks et al., 1974). Well-coordinated ‘turns’ are required in order for a conversation to run smoothly. This involves one speaker talking at a time, although occurrences of overlapping speech, when one speaker talks concurrently with another, are common but generally brief (Sacks et al., 1974). Further, transitions from one turn to the next are often characterized by no gap and no overlap, or by a slight gap or slight overlap (Sacks et al., 1974). The inter-turn speaker latency is assigned to the speaker whose utterance follows the silent period (Kelly and Conture, 1992).

To our knowledge, there are no data that concurrently compare inter-turn speaker latency during a conversational situation where adults are talking to each other and also to children. However, there are data to suggest that, in such a situation, there may be differences. Stivers et al. (2009) explored a related variable of response latency duration for English-speaking adults in 10 languages. Stivers et al. reported, that for questions that require a ‘yes’ or ‘no’ answer, speaker latency is on average less than 200 milliseconds. With a similar one-word response protocol, Boltz (2005) showed that response latency duration can vary, depending on a range of factors, including the communicative intention. It seems that pre-school children, who are still acquiring language, are much slower when taking a conversational turn and, therefore, demonstrate a longer response latency of up to 1000 milliseconds or more (Casillas et al., 2016; Stivers et al., 2018).

Causal theories of stuttering have involved the idea that stuttering occurs in children because an adult speaker is ‘responding to the child faster than the child’s system can tolerate’ (Conture, 2001, p. 46) or because children are attempting to match the speech and language style of adults (Van Riper, 1961). Yet, there is no evidence that parents of children who stutter use decreased speaker latency compared with parents of children who do not stutter (Kelly and Conture, 1992). There is evidence, however, that parents can increase inter-turn speaker latency when instructed to do so (Zebrowski et al., 1996), and that children increase their inter-turn speaker latency in response to increased inter-turn speaker latency by their conversation partner (Newman and Smit, 1989). In fact, it appears that children imitate changes in inter-turn speaker latency more readily than changes to speech rate (Bernstein Ratner, 1992; Welkowitz et al., 1990). There is a potential association between speech rate and inter-turn speaker latency. Studies that focus on reduced parent speech rate have been shown to reduce interruptions or parallel talk, or to naturally increase inter-turn speaker latency (Kelly and Conture, 1992; Ryan, 2000), leading to a reduction of stuttering. However, in two studies (Bernstein Ratner 1992; Sawyer et al., 2017), an increase of inter-turn speaker latency was not associated with significantly slower speech rate.

There is some evidence that increased inter-turn speaker latency modelled by adults can reduce stuttering in young children; a review by Bernstein Ratner (2004) summarizes many of these studies. Winslow and Guitar (1994) used a single subject design to measure a child's stuttering during conversation that included structured turn-taking, and in conversation without structured turn-taking. Structured turn-taking eliminates overlapping speech, which increases overall inter-turn speaker latency. Results indicated a weak correlation between structured turn-taking and a reduction in the frequency of disfluencies. Livingston et al. (2000) investigated the impact of modelling increased inter-turn speaker latency on children who stutter; three children conversed under several conditions: (a) the researcher interrupting the participant's stuttering, (b) the researcher interrupting the participant's fluent speech, (c) the participant interrupting the researcher, (d) the researcher arranging for the participant and researcher to start speaking simultaneously, and (e) the researcher arranging for no interruption. Livingston et al. reported that more stuttering occurred when overlapping speech occurred.

Bonelli et al. (2000) reported data pertinent to whether increased inter-turn speaker latency may be associated with Lidcombe Program treatment outcomes. Using pre-treatment and post-treatment speech samples, they found no evidence to implicate inter-turn speaker latency in the treatment effect. However, that result pertained to treatment *outcome*, and it did not exclude the possibility that inter-turn speaker latency is involved in the Lidcombe Program treatment *process*. For example, it is possible that, during the conduct of the Lidcombe Program, parents increased their inter-turn speaker latency in the practice sessions that are part of the treatment but not part of the Bonelli et al. spontaneous speech sampling procedures.

In summary, the Lidcombe Program is a well-established and efficacious treatment for early stuttering, but its mechanisms of action have not been established. The search to find evidence for verbal contingencies as a mechanism of action for the Lidcombe Program have provided mixed findings. Likewise, no evidence has been found implicating acoustic changes in children's speech and linguistic changes in the speech of children or parents. There are theoretical and empirical reasons to shift that search for a mechanism of action to an interaction between children and their parents. There is evidence that inter-turn speaker latency can provide clinically significant control over stuttering. There are no data that concurrently compare inter-turn speaker latency during a conversational situation where adults are talking to each other and also to children. However, there are data to suggest that, in such a situation, there may be differences.

Conceivably, then, the Lidcombe Program may prompt parents, when they speak to their children at some times during the treatment period, to increase the inter-turn speaker latency they use when speaking with each other. This could occur during the daily practice sessions of the treatment. Hence, the present study explored whether it is possible that clinician behaviour during Lidcombe Program clinic consultations might vicariously model such behaviour to parents. This study is the first report that directly compares inter-turn speaker latency during a conversational situation where adults are talking to each other and also to children.

METHOD

The audio recordings

This observational study used audio recordings (N = 529) of clinicians, parents, and children that were obtained during a previous three-arm clinical trial comparing the Lidcombe Program with two versions of an experimental treatment—the Westmead Program (Trajkovski et al., 2019). Trajkovski et al. (2019) randomized 33 children to a Lidcombe Program treatment group: 24 boys and nine girls, with a mean age 48.8 months (range 30–70 months). The children were treated by five SLPs who worked in one of three research or community clinics in Melbourne or Sydney, Australia. The audio-recordings were of entire 1-hour clinic consultations and included conversations between (a) the SLP and the child and (b) the SLP and the parent. Recordings from the first category comprised SLPs conversing generally with children and/or demonstrating the Lidcombe Program verbal contingencies with children.

Ethics approval

The study was approved by the Human Research Ethics Committee at the University of Technology Sydney (Project ID ETH18-3054). Consent to analyse the recordings was obtained from the five SLPs who provided treatments in the Trajkovski et al. (2019) trial, by means of them signing a Participant Consent Form after reading a Participant Information

Statement. A waiver of consent was approved by the Human Research Ethics Committee for the child and parent participants from the Trajkovski et al. study. This was granted because (1) there was no identifying information on the recordings, (2) participants were recruited to the Trajkovski et al. study more than 6 years prior, and (3) it was unlikely that all participants in that study would be contactable.

Procedure

Inter-turn speaker latency was measured by an investigator. Ten percent (n = 53) of the 529 available audio recordings were selected using a random number generator. Four recordings were excluded from potential inclusion because they did not include instances of conversations between (a) the SLP and the child and (b) the SLP and the parent. This resulted in randomly selected audio recordings from 20 different child participants and the five primary speech pathologists involved in the clinical trial. The random recordings spanned Stage 1 of treatment, during which children attain no stuttering or nearly no stuttering. During the Trajkovski et al. (2019) trial Stage 1 involved a mean of 30 clinic consultations, with a range of 7–36. For each audio recording, a 3-minute sample was isolated, which comprised utterances suitable for analysis of inter-turn speaker latency. Efforts were made to ensure that the 3-minute audio sample captured the largest number of conversational exchanges between the SLP and the child, and between the SLP and the parent. The 3-minute recordings chosen for analysis were from random locations during the 1-hour recordings.

The inclusion criterion for the selection of an utterance for measurement was that the utterance was transcribable using the International Phonetic Alphabet (International Phonetic Association, n.d.). The exclusion criteria for disregarding utterances were as follows: (a) it was unclear who was talking, (b) background noise interfered with the ability to determine onset or end of inter-turn speaker latency, or (c) overlapping talking occurred and it was unclear which speaker was the first to talk. Isolated non-linguistic speech events were ignored if they occurred during a 3-minute audio sample: laughing, coughing, tongue clicking, gulping, sighing, and squealing. Random sampling resulted in audio recordings from 20 different child/parent participants and the five SLPs involved in the clinical trial. The mean number of recordings selected for each of the 20 child/parent participants across the current study was 2.6 (range 1–6). The mean number of all SLP-child conversational turns measured per audio recording was 26 (range 3–64). SLP-parent conversation samples included a mean of 26 conversational turns by SLPs per recording (range 5–47).

Audio recordings were edited to 3-minutes using Audacity software (Audacity® Team, n.d., version 2.3.3). Inter-turn speaker latency was measured using PRAAT software (Boersma and Weenink, n.d.). Inter-turn speaker latency was defined as the silent period that occurs between the moment when one speaker terminates an utterance and another speaker commences an utterance (Newman and Smit 1989). The inter-turn speaker latency was assigned to the speaker whose utterance follows the silent period (Kelly and Conture, 1992), which for this study was the SLP. Each 3-minute audio sample was analysed individually using the PRAAT software. Speech waveforms were generated by the software. Figure 1 presents a waveform of a 2.5 second conversational exchange between a parent and a SLP, which includes an inter-turn speaker latency period.

INSERT FIGURE 1 ABOUT HERE

Measurement reliability

We evaluated relative reliability with Pearson correlation coefficients. Relative reliability determines how well observers rank-order individual scores on different occasions

(Batterham & George, 2003). To evaluate intra-judge agreement for the measure of inter-turn speaker latency, 10% of the analysed samples were selected using a random number generator. Samples were re-measured by the investigator after 1 month. The intra-judge agreement was high at $r = .96$. To evaluate inter-judge agreement, a separate 10% of samples were selected randomly and presented to an independent observer who was blinded to the purpose and hypothesis of the study but who had received training in the analysis protocol. The independent judge was a paediatric speech pathologist with more than 5 years of experience treating children who stutter. One of the inter-judge comparisons for duration of inter-turn speaker latency showed a large discrepancy from the mean comparison value. The cause of this was because one judge included a conversational turn in a measurement and the other judge did not. Using the convention of removing outliers caused by data collection errors prior to correlational analysis (Holmes Finch, 2012), and using the convention of an outlier being more than 3 standard deviations from the mean (Leys et al., 2019), this comparison was removed from the analysis, giving a high inter-rater agreement score of $r = .87$.

RESULTS

Data analysis

For each of the 53 samples, we averaged the inter-turn speaker latency for SLP-child and for SLP-parent. The mean SLP-child inter-turn speaker latency was 0.313 seconds ($SD = 0.166$, min = 0, max = 0.8151). The mean SLP-parent inter-turn speaker latency was 0.167 seconds ($SD = 0.105$, min = 0, max = 0.5151). Results are summarized in Figure 2.

Data were analysed using paired *t*-tests to compare the mean SLP-child inter-turn speaker latency with the mean SLP-parent inter-turn speaker latency. The result was significant $t(5.39)$, $p < .001$. Data were also grouped and analysed for the 20 individual children in the sample. A two-tailed paired *t*-test of those data was also significant $t(3.97)$, $p < .001$.

INSERT FIGURE 2 ABOUT HERE

DISCUSSION

Summary of results

The purpose of this observational study was to determine whether it is possible that SLPs might increase their inter-turn speaker latency with children during Lidcombe Program clinic consultations. These unique data concurrently compare inter-turn speaker latency during a Lidcombe Program consultation where adults are talking to each other and also to children. Results showed that the five SLPs who provided Lidcombe Program treatment did increase their inter-turn speaker latency, in comparison with when they were speaking to parents.

Study strengths and limitations

The present results assume that the speech samples for the five clinicians analysed in this study can be generalized to the clinical community. Additionally, a limitation of the study was that it only analysed SLP-parent and SLP-child interactions. The study design did not allow exploration of whether that modelling vicariously invoked a change in parent-child interaction, and whether that change was associated with stuttering reduction. However, a strength of the study is that the behaviour of the five SLPs could not have been biased by knowledge of the study purpose because the speech samples were collected before the study was conceptualized and designed. Another study strength is that it is free from potential clinician bias. The random selection of data for inclusion from the 529 audio recordings of Lidcombe Program Stage 1 clinic consultations were from a prior study.

Discussion of results

To our knowledge, this is the first direct demonstration of a difference between adult-adult and adult-child inter-turn speaker latency during the same conversational situation, and it shows that effect during Lidcombe Program clinical consultations. Results are broadly consistent with data suggesting that pre-schoolers have a much longer inter-turn speaker latency than adults (Casillas et al., 2016; Stivers et al., 2018; see *Introduction*). Hence, when talking to pre-schoolers, the clinicians in the present study may have adapted their speech to accommodate the children's longer latencies while demonstrating the Lidcombe Program verbal contingencies to parents. Such clinician behaviour is not a part of the Lidcombe Program procedures given in the treatment guide (Onslow et al., 2021). This result raises the possibility that inter-turn speaker latency may be involved in the Lidcombe Program treatment process vicariously.

As noted in the Introduction, there is evidence that parents can increase inter-turn speaker latency if instructed to do so, and that this may prompt children to increase their response latency. As also noted in the Introduction, inter-turn speaker latency figures prominently in RESTART-DCM treatment, which has been shown in a clinical trial to have positive outcomes in terms of reducing stuttering (de Sonneville-Koedoot et al., 2015). However, it is not clear how increasing inter-turn speaker latency reduces stuttering, as suggested by laboratory studies (Livingston et al., 2000; Winslow & Guitar; 1994; see *Introduction*). Neither the de Sonneville-Koedoot et al. (2015) trial nor the RESTART-DCM treatment manual (Franken & Putker-de Bruijn, 2007) explain how that strategy might attenuate stuttering, apart from broad indications that it is consistent with the general tenets of the Demands and Capacities model. However, a more specific theoretical explanation is offered by the P&A 3-factor Model of Moments of Stuttering (Packman, 2012). This model proposes that moments of stuttering are triggered when certain speech motor demands of spoken language, such as language complexity, are not met immediately by the compromised neural brain processing that is known to be present in people who stutter. According to the P&A Model, however, the threshold for that triggering can be *lowered* by internal factors such as physiological arousal. Thus, we suggest that pausing reduces the demands on the child to respond immediately to the parent and, thus, gives the child time to think about and compose what they want to say. That is, it can *raise* the threshold for the triggering of stuttering moments.

Future research

Future aims for research need to include determination of whether clinician modelling of increased inter-turn speaker latency during clinic consultations does, in fact, constitute a vicarious treatment model for parents. Such research would determine whether parents, when conducting the Lidcombe Program during everyday speaking situations, speak to their children with increased inter-turn speaker latency, and whether that behaviour is responsible for stuttering attenuation.

If parents do increase their customary inter-turn latency in addition to providing verbal contingencies to their children, the former variable may be an active mechanism of action alone, or it may be so in combination with verbal contingencies. The latter prospect appears realistic. Indeed, it appears unlikely that any program of research would reveal a single mechanism of action underpinning the Lidcombe Program. This seems to be a justified prediction, given that two reports have provided partial support for the contribution of verbal contingencies to treatment effects (Donaghy et al., 2020; Harrison et al., 2004; see *Introduction*).

The clinical utility of the present findings is far from being established. There is much empirical work to be done to explore parent inter-turn speaker latencies and other potential mechanisms of action for Lidcombe Program treatment. Ultimately, such a program of research might increase the efficiency of early stuttering treatment. If it was shown that increased inter-turn speaker latency was a predominant Lidcombe Program mechanism of action, that finding would signal potential developmental prospects for a new early stuttering intervention. In principle, such an intervention would be simpler than the Lidcombe Program, containing only parent instruction to increase inter-turn speaker latencies when conversing with children, and practical guidance for how and when to do so. The simplicity and efficiency of such a treatment is a compelling prospect. In contrast to the Lidcombe Program, such an intervention is not only simpler, but it would have the ultimate advantage that there would be no need for the child to actively participate in the treatment process (Onslow & Lowe, 2019); the treatment would comprise a simple change to parent language behaviour. The prospect of such a development warrants continued exploration of the present findings.

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DISCLOSURE OF INTEREST

The authors report no conflict of interest

DATA AVAILIBILITY STATEMENT

Data available on request due to privacy/ethical restrictions

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Figure Captions

Figure 1: Waveform representing SLP-parent conversation

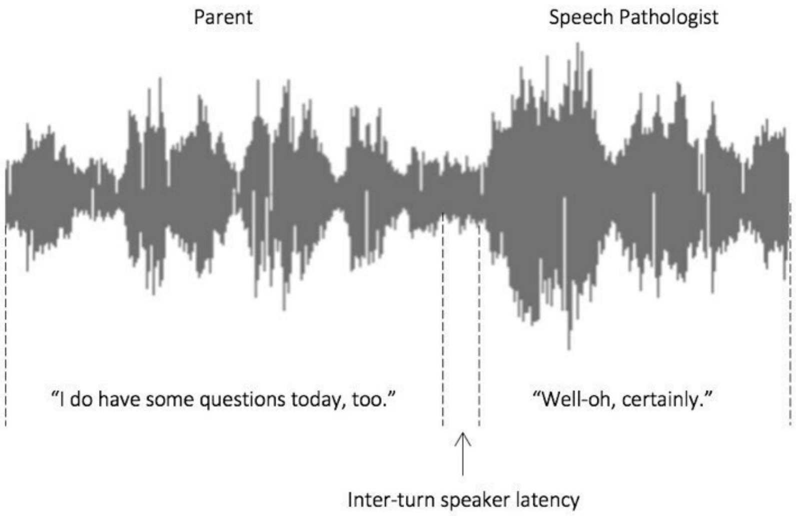

Figure 2: SLP mean inter-turn speaker latency and showing 1 standard deviation